4.5 Fish and Wildlife Surveillance

T. M. Poston, M. L. Blanton, and G. W. Patton

Contaminants in fish and wildlife that inhabit the Columbia River and Hanford Site are monitored for several reasons. Wildlife have access to areas of the site containing radioactive or chemical contamination, and fish can be exposed to contamination entering the river along the shoreline. Fish and some wildlife species exposed to Hanford contaminants might be harvested for food and may potentially contribute to offsite public exposure. In addition, detection of contaminants in wildlife may indicate that wildlife are entering contaminated areas (e.g., burrowing in waste burial grounds) or that materials are moving out of contaminated areas (e.g., through blowing dust or food-chain transport). Consequently, samples are collected at various locations annually, generally during the hunting or fishing seasons (Figure 4.5.1). More detailed rationale for the selection of specific species sampled in 1997 can be found in DOE/RL-91-50, Rev. 2.

Routine background sampling is conducted approximately every 5 years at locations believed to be unaffected by Hanford releases. Additional background data also may be collected during special studies.

As a result of changing site operations, fish and wildlife sampling frequencies were modified significantly in 1995. Species that had been collected annually were placed on a rotating schedule so that surveillance of all key species would be accomplished over a 3-year period. Factors supporting these changes included the elimination of many radiological source terms onsite and a decrease in environmental concentrations of radionuclides of interest. Additionally, several radionuclides that were monitored in the past had not been detected in recent wildlife samples because they were no longer present in the environment in sufficient amounts to accumulate in wildlife or they did not accumulate in fish or wildlife tissues of interest.

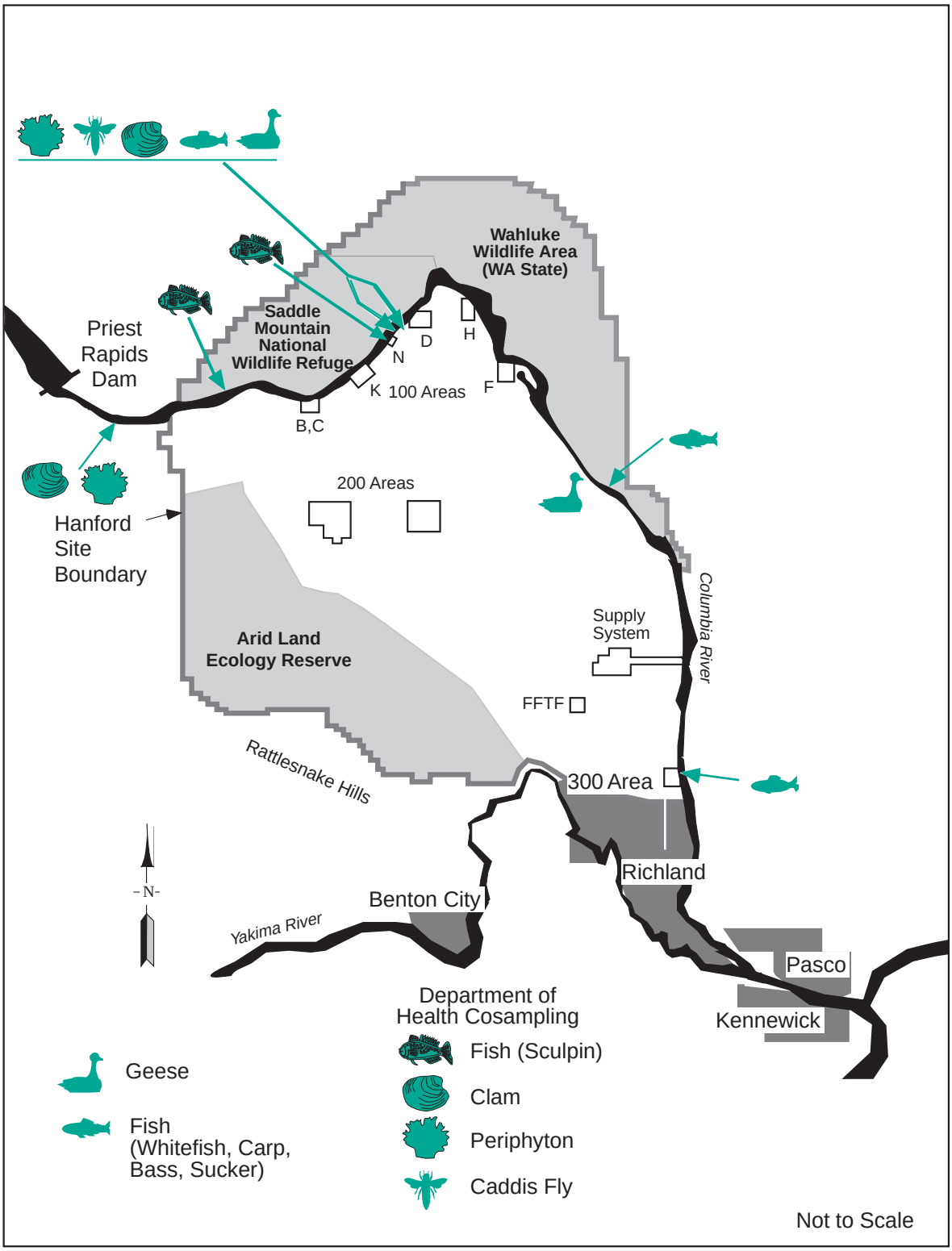
For each species of fish or wildlife, radionuclides are selected for analysis based on the potential for the contaminant to be found at the sampling site and to accumulate in the organism (Table 4.5.1). At the Hanford Site, strontium-90 and cesium-137 historically have been the most frequently measured radionuclides in fish and wildlife.

Strontium-90 is chemically similar to calcium; consequently, it accumulates in hard tissues high in calcium such as bone, antlers, and eggshells. Strontium-90 has a long biological half-life in hard tissue (14 to 600 d). Hard-tissue concentrations may profile an organism's lifetime exposure to strontium-90. However, strontium-90 generally does not contribute much to human dose because it does not accumulate in edible portions of fish and wildlife. Spring water in the 100-N Area is the primary source of strontium-90 from Hanford to the Columbia River; however, the current contribution relative to historical fallout from atmospheric weapons testing is small (<2%) (PNL-8817).

Cesium-137 is particularly important because it is chemically similar to potassium and is found in the muscle tissue of fish and wildlife. Having a relatively short biological half-life (<200 d in muscle; <20 d in the gastrointestinal tract), cesium-137 is an indicator of more recent exposure to radioactive materials, and is also a major constituent of historical fallout.

Fish and wildlife samples were analyzed by gamma spectrometry to detect a number of gamma emitters (see Appendix E). However, gamma spectrometry results for most radionuclides are not discussed here because concentrations were too low to measure or measured concentrations were considered artifacts of low background counts. Low background counts occur at random intervals during sample counting and can produce occasional spurious false-positive results.

For many radionuclides, concentrations are below levels that can be detected by the analytical laboratory. When this occurs for an entire group of samples, two times the total propagated analytical error is used as an estimate of the nominal detection level for that analyte and particular media. Results and propagated uncertainties for all results may be found in PNNL-11796.



SP98030012.4

Figure 4.5.1. Fish and Wildlife Sampling Locations, 1997

Table 4.5.1. Locations, Species, and Contaminants Sampled for Fish and Wildlife, 1997

Medium	No. of Species	Offsite Locations	Onsite Locations	Contaminants Sampled/No. of Locations		
				Gamma	Strontium-90	Metals
Fish (Whitefish, bass, carp, suckers, sculpins)	5	1[a]	4	1	1	4
Geese	1	0	2	2	2	0
Rabbits	0[b]	0	0	0	0	0

(a) Background samples of sculpins collected near Vernita Bridge.
(b) Rabbit sampling suspended because of low jackrabbit populations.

4.5.1 Collection of Fish Samples and Analytes of Interest

In 1997, whitefish were collected from the Columbia River (i.e., that section of the river that includes the 100-N through 100-D Areas). Electrofishing near the 300 Area did not yield any whitefish. Results for whitefish collected in 1997 are compared to background fish collected in the Wenatchee River in 1995. Sculpins were also collected near the 100-N Area and from an upriver site near the Vernita Bridge as part of a collaborative study with the Washington State Department of Health. Sculpins are bottom-dwelling fish that are believed to reside in small home ranges. Consequently, they may be better indicators of localized contamination. Composite whole body samples (less liver) of sculpins were analyzed for gamma emitters and strontium-90.

Liver and kidney tissues were sampled from smallmouth bass, suckers, and carp collected near the 300 Area, Old Hanford Townsite, and the 100-N to 100-D Areas in August 1997. These samples were analyzed for metals. In addition to these samples, composite liver samples from sculpins were also collected at 100-N and the Vernita Bridge for metals analysis.

Bass, carp, suckers, and whitefish are very mobile, and the length of time they reside at any given sampling location is unknown. This mobility may explain why analytical results for these four species of fish generally are variable.

Fillets and the eviscerated remains (offal) were analyzed for contaminants. All analytical data for 1997 samples are listed in PNNL-11796.

4.5.2 Radiological Results for Fish Samples

4.5.2.1 Whitefish

Muscle. In 1997, muscle samples were analyzed with gamma spectrometry for cesium-137 and other gamma-emitting radionuclides (see Appendix E). Cesium-137 was detected in one of four whitefish fillet samples collected (0.03 ± 0.02 pCi/g) in 1997. The 1997 results were similar to the results obtained over the preceding 5 years (Table 4.5.2).

Offal. Strontium-90 was found in 1 of 3 whitefish offal samples analyzed in 1997. Mean concentrations of strontium-90 in offal in 1997 were lower than had been observed in the preceding 5 years, and were lower than levels observed in the background samples collected from the Wenatchee River in 1995.

Overall, radionuclide concentrations in Hanford Reach whitefish were similar to the levels observed in background whitefish. The associated dose from the hypothetical consumption of whitefish is found in Section 5.0, "Potential Radiological Doses from 1997 Hanford Operations."

Table 4.5.2. Concentrations of Selected Radionuclides in Whitefish, 1997 Compared to Previous 5 Years

Location	1997 Maximum,[a] pCi/g wet wt.	1997 Mean,[b] pCi/g wet wt.	1997 No. Less Than Detection[c]	1992-1996 Maximum,[a] pCi/g wet wt.	1992-1996 Mean,[b] pCi/g wet wt.	1992-1996 No. Less Than Detection[c]
Cesium-137 in Muscle						
100-N through 100-D Areas	0.03 ± 0.02	0.01 ± 0.02	3 of 4	0.17 ± 0.04	0.03 ± 0.01	26 of 38
Wenatchee River	NS[d]	NS		0.00 ± 0.01	0.004 ± 0.003	4 of 7
Strontium-90 in Offal						
100-N through 100-D Areas	0.033 ± 0.004	0.011 ± 0.022	2 of 3	0.46 ± 0.006	0.034 ± 0.028	1 of 33
Wenatchee River	NS	NS		0.071 ± 0.018	0.049 ± 0.010	0 of 6

(a) Maximum is ± total propagated analytical uncertainty (2-sigma).
(b) Result is ±2 standard error of the mean.
(c) Number of samples with values less than the detection limit out of number of samples analyzed.
(d) NS = No sample.

4.5.2.2 Sculpins

Gamma emitters (nominal detection limit of 0.05 pCi/g) were not detected in composited sculpin samples from the 100-N shoreline or in samples collected from the upstream background location near the Vernita Bridge. The 100-N composite sample contained 0.75 ± 0.15 pCi/g strontium-90 compared to the upstream control concentration of 0.015 ± 0.009 pCi/g. Sculpins have disproportionately larger skulls than other fish routinely sampled in the Hanford Reach. The relatively larger skull in sculpins may influence the higher concentrations of strontium-90 observed in whole body samples of this species. The higher concentration found in the 100-N sample is attributed to the species small home range and greater potential exposure to 100-N groundwater seepage.

4.5.3 Wildlife Sampling

Wildlife scheduled for collection in 1997 for radioactive constituents included rabbits and geese. Jackrabbit populations statewide are down, and observations of site pest management and wildlife management staff indicated that the Hanford Site rabbit population was greatly depressed in 1997. Attempts to collect rabbits did not result in any sightings and rabbit collections were suspended. Collections of geese were successful for all locations. Data from all 1997 samples are given in PNNL-11796.

4.5.3.1 Collection of Goose Samples and Analytes of Interest

Resident Canada geese were collected from the 100-N through 100-D Areas and the Old Hanford Townsite in the summer of 1997. Radionuclide concentrations in these samples were compared to samples collected from the same locations in 1995.

4.5.3.2 Radiological Results for Goose Samples

Muscle. Cesium-137 was detected in 2 of 10 Canada goose muscle samples collected in 1997 (Table 4.5.3). Concentrations were close to the detection limit of 0.02 pCi/g and were similar to concentrations observed in 1995. Strontium-90 was measured in 2 of 10 muscle samples at levels very close to the detection limit of 0.005 pCi/g.

Bone. Strontium-90 was measured in 8 of 10 bone samples collected onsite in 1997. The mean concentrations

Table 4.5.3. Concentrations of Selected Radionuclides in Canada Geese, 1997 Compared to 1995

Location/Tissue (Radionuclide)	1997 Maximum, pCi/g[a]	1997 Mean, pCi/g[b]	1997 No. Less Than Detection[c]	1995 Maximum, pCi/g[a]	1995 Mean, pCi/g[b]	1995 No. Less Than Detection[c]
100-N through 100-D Areas						
Bone (^{90}Sr)	0.15 ± 0.043	0.091 ± 0.040	0 of 5	0.717 ± 0.164	0.313 ± 0.284	0 of 5
Muscle (^{90}Sr)	0.005 ± 0.004	0.004 ± 0.001	4 of 5	0.002 ± 0.002	0.000 ± 0.001	5 of 5
Muscle (^{137}Cs)	0.04 ± 0.02	0.02 ± 0.02	3 of 5	0.01 ± 0.01	0.01 ± 0.00	5 of 5
Old Hanford Townsite						
Bone (^{90}Sr)	0.15 ± 0.048	0.066 ± 0.046	2 of 5	0.439 ± 0.112	0.220 ± 0.141	0 of 5
Muscle (^{90}Sr)	0.010 ± 0.006	0.004 ± 0.004	4 of 5	0.001 ± 0.003	0.000 ± 0.001	5 of 5
Muscle (^{137}Cs)	0.02 ± 0.02	0.00 ± 0.01	5 of 5	0.01 ± 0.01	0.00 ± 0.01	5 of 5

(a) Maximum is ±2 total propagated analytical uncertainty (2-sigma).
(b) Result is ±2 standard error of the mean.
(c) Number of samples with values less than the detection limit out of number of samples analyzed.

of strontium-90 in bone samples collected from both locations were generally lower than concentrations observed in 1995 (see Table 4.5.3).

4.5.4 Nonradiological Results for Fish and Other Aquatic Organisms

Fish and several other aquatic organisms were collected from the Hanford Reach in 1997 as part of ongoing efforts to better understand the distribution and significance of metals. Fish kidney and liver samples were analyzed for metals. Other aquatic organisms including periphyton (assemblages of sponges, sessile algae, protozoans, and microinvertebrates found on cobble substrate), emergent adult caddis flies, and clams (soft tissue and shells) were also analyzed for metals. Samples were analyzed using two methods: cold vapor atomic adsorption spectrometry for the analysis of mercury and inductively coupled plasma emission spectrometry/mass spectrometry for the analysis of antimony, arsenic, cadmium, chromium, copper, nickel, lead, silver, selenium, thallium, and zinc. The metals data reported here represent an initial characterization effort to evaluate current concentrations of metals in Columbia River fish and aquatic biota.

4.5.4.1 Metals Analysis in Fish

Metals analysis was conducted on livers and kidneys collected from smallmouth bass, suckers, and carp. Five fish of each species were collected from the Columbia River adjacent to the 300 Area, Old Hanford Townsite, and 100-N through 100-D Areas.

Sculpins, which are considerably smaller than the other species, were collected near the 100-N Area and near the Vernita Bridge as part of a collaborative study with the Washington State Department of Health. Livers from these fish were used to prepare a composite sample from each study area.

4.5.4.2 Analytical Results

Metals data are summarized in tabular form in Appendix A (Tables A.8 and A.9). In recent years, chromium has been the focus of numerous site investigations and cleanup actions because it is known to enter the Columbia River in groundwater seeps along the Hanford shoreline. The chromium data for fish do not indicate any specific relationships between river location, tissues samples, or species (Figure 4.5.2). Concentrations of chromium ranged from less than detection (0.2 mg/g) to 1.2 mg/g dry weight in liver and kidney samples. Generally, liver and kidney concentrations were similar and there was no apparent

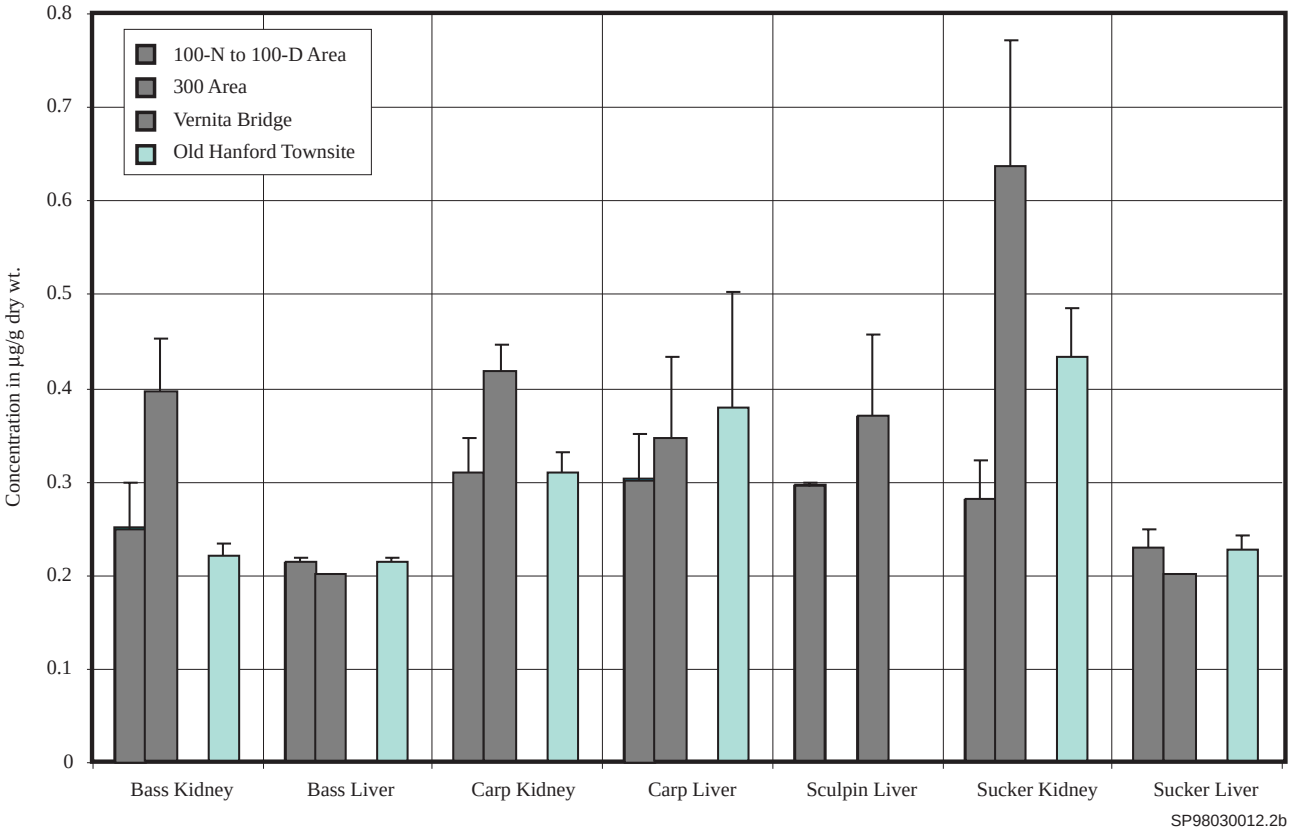


Figure 4.5.2. Chromium Concentrations (mean ±1 standard error of the mean) in Livers and Kidneys of Hanford Reach Fish, 1997

difference between species or locations sampled (see Figure 4.5.2). Carp appeared to be more prone to adsorption of metals than bass, suckers, and sculpins. The highest kidney concentrations of arsenic, cadmium, lead, thallium, and zinc were observed in carp. Additionally, the highest liver concentrations of copper and zinc were observed in carp. Zinc concentrations in carp liver and kidney samples exceeded concentrations in the comparable organs of bass, suckers, and sculpins by a factor of four or greater (Figure 4.5.3). Among bass, suckers, and sculpins, concentrations of other metals in liver and kidney samples were generally similar with no consistent and discernible distinction observed between the areas sampled (see Appendix A).

4.5.4.3 Metals Analysis in Other Aquatic Organisms

Periphyton, clams (shells and soft tissue), and emergent caddis flies were also sampled as part of the collaborative study with the Washington State Department of Health at 100-N Springs. Upstream control samples were collected between Priest Rapids Dam and Vernita Bridge on the Benton County side of the river. Obtaining enough caddis fly sample mass for analyses was difficult, and living clams were not found at the upstream control location.

4.5.4.4 Analytical Results

Chromium, copper, and zinc were found in the highest concentrations in the soft tissue of clams and in periphyton (Table 4.5.4). Beryllium and antimony were detected in periphyton samples, but were below detection in clam tissue. Overall, metals results are within the range of expected concentrations and are undergoing further evaluation with respect to fish, sediment, and water concentrations to gain a better understanding of trace metal distribution in the Columbia River ecosystem.

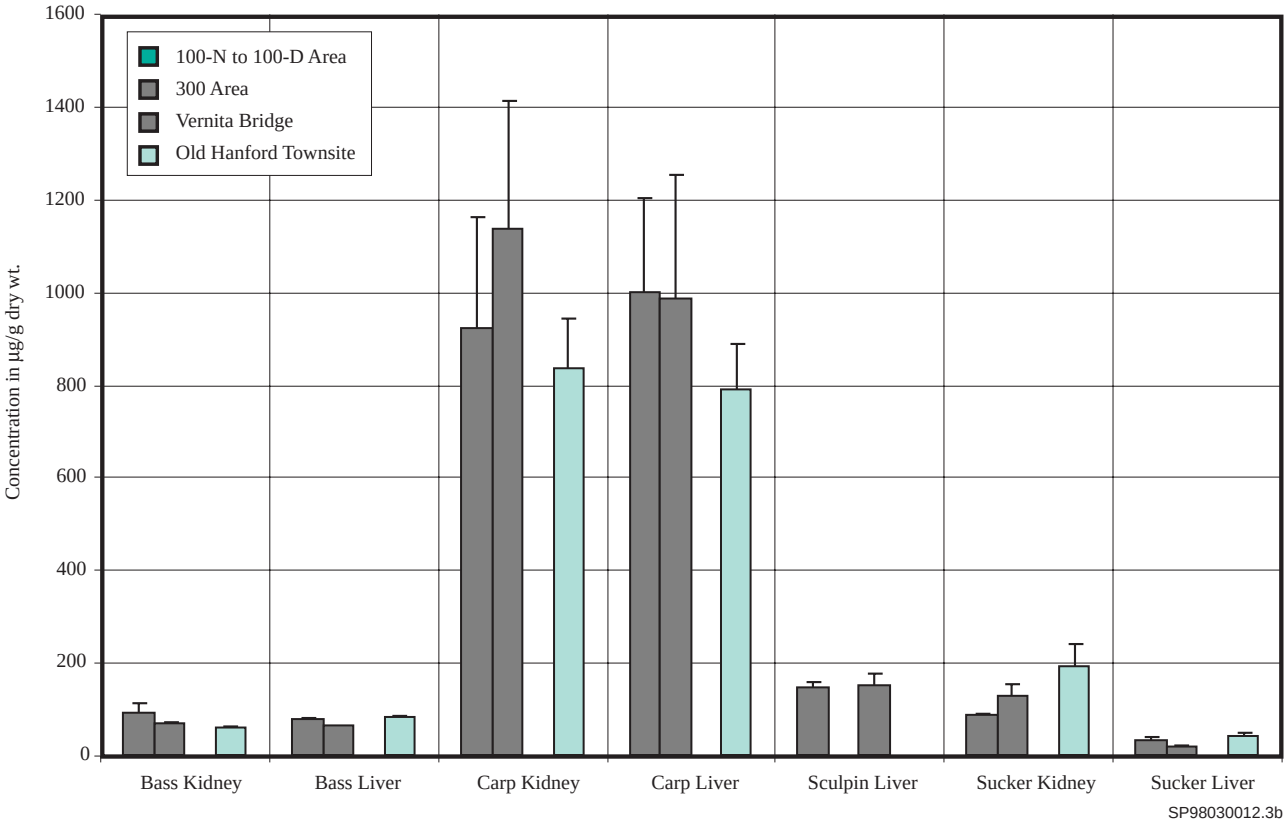


Figure 4.5.3. Zinc Concentrations (mean ±1 standard error of the mean) in Livers and Kidneys of Hanford Reach Fish, 1997

Table 4.5.4. Comparison of Metals Concentrations in Other Aquatic Organisms, 1997

Organism	Sampling Location	No. of Samples	Data	Concentrations, µg/g dry wt. Antimony	Arsenic	Beryllium	Cadmium	Chromium	Copper	Lead
Caddis fly Adult	100-N Area	2	Mean	0.10	0.97	0.15	0.89	0.57	31.0	0.87
			Maximum	0.19	1.0	0.15	0.75	0.73	33.0	1.2
			Minimum	0.015	0.93	0.15	0.62	0.41	29.0	0.53
	Upstream of Vernita Bridge	1	Result	0.054	1.2	0.15	0.91	0.52	35.0	1.5
Larva	100-N Area	1	Result	0.015	3.7	0.49	2.5	12.7	27.0	12.0
Clam muscle	100-N Area	2	Mean	0.015	10.004	0.15	4.025	11.503	56.86	1.733
			Maximum	0.015	15.74	0.15	5.557	19.8	92.26	2.998
			Minimum	0.015	4.268	0.15	2.493	3.206	21.46	0.468
Clam shells	100-N Area	1	Result	0.019	0.11	0.15	0.066	0.25	3.016	0.206
	Upstream of Vernita Bridge	1	Result	0.015	0.505	0.15	0.325	1.912	9.847	2.693
Periphyton	100-N Area	3	Mean	0.063	7.118	0.661	2.858	33.073	39.863	36.19
			Maximum	0.088	8.252	0.809	3.519	35.01	45.01	49.18
			Minimum	0.035	5.954	0.546	2.31	29.62	36.78	29.56
	Upstream of Vernita Bridge	1	Result	0.046	5.801	0.739	1.81	31.59	33.52	34.33
	Detection Limit			**0.015**	**0.030**	**0.150**	**0.020**	**0.200**	**0.020**	**0.036**

Table 4.5.4. (contd)

Organism	Sampling Location	No. of Samples	Data	Concentrations, µg/g dry wt. Mercury	Nickel	Selenium	Silver	Thallium	Zinc
Caddis fly Adult	100-N Area	2	Mean	0.029	0.36	1.1	0.049	0.035	140
			Maximum	0.033	0.49	1.1	0.053	0.039	140
			Minimum	0.025	0.23	1.1	0.045	0.032	140
	Upstream of Vernita Bridge	1	Result	0.038	0.42	1.8	0.045	0.035	177
Larva	100-N Area	1	Result	0.028	11.0	2.1	0.11	0.34	154
Clam muscle	100-N Area	2	Mean	0.04	1.119	3.139	0.074	0.296	99.56
			Maximum	0.05	1.498	3.918	0.082	0.358	107.4
			Minimum	0.03	0.74	2.36	0.066	0.234	91.72
Clam shells	100-N Area	1	Result	0.001	11.61	1	0.045	0.048	1.955
	Upstream of Vernita Bridge	1	Result	0.002	12.28	1	0.045	0.123	26.77
Periphyton	100-N Area	3	Mean	0.074	26.703	1.36	0.15	0.491	228.767
			Maximum	0.089	28.65	1.448	0.189	0.633	259.6
			Minimum	0.057	25.07	1.194	0.121	0.401	210.4
	Upstream of Vernita Bridge	1	Result	0.041	26.08	1	0.139	0.498	259.1
	Detection Limit			**0.001**	**0.020**	**1.0**	**0.045**	**0.005**	**0.150**